

## ORIGINAL ARTICLES

## TRAUMATISM OF THE BRAIN.\*

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In discussing traumatism of the brain, it would be well to keep in mind a few simple facts relating to the anatomy, physiology and pathology of this organ. It is made up of the most delicate tissue, and is most richly supplied with blood. Because of the softness of the tissue, the blood vessels themselves have very little support. It is surrounded by an inelastic membrane, which is again surrounded by bone. When it is injured, it has very little opportunity to give in any direction for the relief of the following edema, except only the removing from the brain cavity the cerebrospinal fluid and the blood in the blood vessels. When one remembers the vital centers protected so well by the skull but so feebly by the tissue of the brain, the symptoms seen in cases of injury are readily understood, but with equal difficulty interpreted.

It is well known that contusion of tissue results in edema, and if great enough to break the blood vessels, in hemorrhage. In the case of the ordinary tissues of the body, which are elastic and can cause very little trouble by their swelling, the result is not serious. In the case of the brain, things are quite different. The contusion of brain tissue, which may not even lead to a well-marked hemorrhage, may result in edema. This edema, because of the lack of support for the soft-walled veins, will infringe upon the outlet of the circulation to a part or parts, while the harder walled arteries are still freely open, resulting in greater venous congestion, and finally, on account of the pressure thus exerted, will reach a time when the arteries themselves will be shut off and an anemia of the brain tissue nearby result. This condition of affairs will be found in all grades in the same brain should the injury be great enough and will account for the errors of judgment when interpreting symptoms.

If a crate of eggs be dropped or thrown upon a hard surface, and the crate then opened, one will discover at times that an egg will be broken in the midst of a number of uninjured eggs, many on the side of the crate which struck the hard surface, and a number on the side of the crate opposite, with here and there an egg broken throughout; which, roughly, fairly illustrates the breaks in brain tissue resulting from trauma.

I have never seen death directly result from a fracture of the vault of the skull, provided the injury was made with a more or less pointed instrument or a rapidly moving object with a glancing blow, where the force was exerted upon a small area of the brain, causing trauma of small moment at the base. A skull thrown against a pavement by an automobile moving rapidly, for instance, because of the slight giving of the bone, may result in no fracture which can be demonstrated; but if the force was sufficient, at operation or autopsy I have seen brains filled with many separate hemorrhages, others with enormous hemor-

rhages, some at the base, some over the silent area of the frontal lobes, some coming from a tear of the middle meningeal, others from a rent in the large sinuses, or from connecting veins, remote from the scene of operation. I have learned to call these brains with such numerous tears of tissue, "addled," because it does seem at times as though the soft brain tissue had been shaken apart everywhere. The symptoms and the time of their development depend entirely upon the extent of the trauma, from simple concussion, to the wild, hopeless appearing symptoms of one of these "addled" brains.

It must be kept in mind that our whole object in the treatment of brain injuries is to prevent the extension of pressure to the vital centers in the bulb.

It has become almost an axiom at the Central Emergency Hospital that, "in case of a so-called fracture of the base of the skull, which requires immediate operation because of the well-marked symptoms of compression, operation is useless, and the case is hopeless." This is because the trauma was so severe that the bulb tissue was torn, and not because the vital centers were pressed upon by extension of swelling from a distant injury.

The extradural hemorrhage usually resulting from a tear in the middle meningeal artery, gives the clearest picture: symptoms of concussion with recovery therefrom and a conscious interval, followed by coma.

Hemorrhages under the dura which, of course, are the commonest, if they happen to be localized, at first give the picture of pressure, with its early paralysis, followed by venous congestion with its irritating symptoms, and later signs of anemia of brain tissue, can be relieved by operation before brain tissue is destroyed and before the pressure has been exerted long enough by the hemorrhage to extend the edema to the vital centers in the bulb, when as a rule operation is too late. Hemorrhages in the brain tissue and in the ventricles are usually a result of the "addled" brain type, and no operation seems of value.

The main points to be kept in mind are these: The usual signs of compression spoken of in most of the books on surgery, such as slow pulse, changes in the pupils and retina, alterations in the breathing and temperature, are all symptoms of trouble in the bulb.

The vital centers are involved and things have gone quite far enough, if not too far. If one remembers that cerebral anemia stimulates the vasomotor centers, and arterial blood pressure rises, while the same anemia causes a paralysis of the respiratory center and respiration will be involved; then, if one waits for the much lauded sign of high blood pressure before operating, the chances are that tissue has been destroyed, and we are too late. I feel certain that operation has not been done early enough when indicated.

Low blood pressure has been the rule in most instances, in my experience, in the type of injury which seems to demand immediate operation. This is probably due to the fact that other vital centers were badly injured at the time of the accident,

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and the vasomotor center escaped. Blair reports that 63 patients not operated upon who lived more than two hours, 35% survived; of the 42 patients operated upon, 57% survived. In one-half of the successful cases, but in only one-third of the fatal case, the operation had been done within two hours. Of the patients on whom the dura was opened within two hours, 70% survived. Of those not operated upon who survived 24 hours, 58% ultimately recovered; of those operated upon who survived 24 hours, 75% recovered. This shows that the time of operation is important.

Blair thinks the most constant single sign of severe brain injury is disturbance of the pupillary reflex. Of patients giving this sign in the series without operation, 27% recovered; with operation, 57% recovered. I have seen reacting operation in some of the rapidly fatal cases, and abnormal pupils in some who have recovered.

Bleeding from the ears is spoken of as direct evidence of fracture of the skull. It, of course, is to be taken in connection with other symptoms in judging the extent of injury. The final outcome of such injury to the middle ear and drum is best known to ear specialists. The eye specialist will be called on at times to see these patients, and if the case has been left long enough, there will be seen changes in the eye-ground, such as choked disc and small hemorrhages of the retina.

It is well to remember that the operation of decompression, if proper care is used that no blood is lost unnecessarily as the patient is already in shock, can of itself do no harm. The operation will certainly prevent the spread of edema to the vital centers from a disturbed part, and will often save the lives of these patients. It certainly can in no way endanger them.

It might be of interest to report two types of cases.

One patient, J. B., came into the Central Emergency Hospital with a history of having been struck on the head two days before. He was conscious, but said he felt dizzy. His pulse at the time was 80, his blood-pressure 120, the temperature normal, the right pupil somewhat larger than the left, both reacting to light. He was kept for observation, and in the course of some hours became unconscious. His pulse dropped to 60 and he developed a left hemiplegia, complete. I did a right, subtemporal decompression, encountering an enormous extradural clot, so large that one would think it impossible that the brain could be so compressed and not destroyed. This was removed, and in three days the patient was able to walk. This is one of the cases of slow clot formation where the bulb was not injured.

Another case, Mr. A. B., was brought to the Central Emergency Hospital with a history of having one hour before been struck by a "jitney" on Market street. He came in with a blood-pressure of 140, a pulse of 150, which in the course of one hour dropped to 120, was totally unconscious, and the pupils dilated but reacting to light. He was in complete coma on admission and breathing was markedly disturbed. He became very restless, and was one of the cases which seem hopeless from the start. A double decompression operation was done upon him two days afterward which, of course, was too late. The cerebrospinal fluid was clear, and small hemorrhages could be seen in the pia. The patient died, and Dr. Schaller has very kindly brought the brain for you to see. It will be very evident to you

why any operation was useless, and will demonstrate to you after you see the enormous number of hemorrhages throughout this brain, why he appeared hopeless at once. The autopsy showed absolutely no fracture of the skull.

#### Discussion.

Dr. W. F. Schaller: I wish to show you the hardened brain of one of the cases, Mr. A. B., whose symptomatology has just been detailed by Dr. Weeks. The symptoms left little doubt in our minds that there was a fracture at the base, but after death, which occurred three days after the injury, no fracture was found at autopsy although the periosteum was scraped carefully from the base of the skull and the foramina carefully explored. The fact that there were extensive hemorrhages in the tissues about the orbit and in the conjunctiva on the right side made the absence of any fracture noteworthy. When the brain was removed, small subpial hemorrhages were seen in the hemispheres but the brain was not lacerated, and did not show any marks of violence. The interior of the brain, however, on section after hardening in 10% formalin, showed a remarkable picture. In the anterior portion of both frontal lobes, in the region adjacent to the knee of the corpus callosum, and in the callosal fibres themselves were seen extensive minute hemorrhages which in some areas caused a disorganization of brain tissue. There was no evidence of edema of the brain at autopsy nor could any other pathological condition be found on careful macroscopical serial section. The medulla and midbrain appeared quite normal. Dr. E. S. May of Oakland is making a further histological study of the cerebral cortex.

Dr. Cullen F. Welty: I wish to report some thirty-two cases of fracture of the base of the skull. The diagnosis of fracture of the base of the skull was made by lessened bone conduction on one side or the other, in comparison with the opposite side. Some few years since, it was demonstrated beyond a question of doubt that concussion of the labyrinth will sometimes produce a lessened bone conduction. So, the inference is that they were not all fractures of the base. Ten of these cases were followed by acute purulent otitis media. Of these eight cases had partial or complete facial paralysis. As the suppuration subsided, the facial paralysis cleared. Four cases demanded mastoid operations. One case had sinus thrombosis. I wish to make a statement that I consider very important, and that is, in a given case of fracture of the base followed by acute purulent otitis media, operation should be done on the slightest indication of pus retention (or rather acute mastoiditis with pain), because of the possible communications with the brain cavity itself. Furthermore, I wish to say that a fracture of the base in an individual who has a chronic suppurative otitis media should be operated at once for obvious reasons. I am not familiar with the class of cases Dr. Weeks speaks of. I never see them. My reported cases were from the City and County Hospital, following the great fire. Two cases were private. All the cases that I treated recovered.

Dr. Emmet Rixford: I regret that I did not hear all of Dr. Weeks' paper, for I have gathered from its latter part the probably erroneous impression that Dr. Weeks considered the determination of indication for operation in fracture of the base of the skull a simple matter. With this I can not at all agree for it is contrary to the accepted teaching of those of the greatest experience in this field. As for me, with the growth of my personal experience which now has become considerable, I look with greater and greater apprehension upon the cases of fracture of the skull with traumatic injury of the brain which come to me.

I have had some very hard knocks in this matter. I have operated and been proud to have found a linear fracture of the skull and had the patient die I fear as much from my operation as from

the original injury, and I have had the opposite experience of having advised against operation where autopsy subsequently showed conditions that might have been alleviated by a timely operation.

Not every case of fracture of the skull requires operation, especially fractures of the base. In fact a large proportion of the cases as we meet them have conditions of contusion or laceration of the brain substance for which little or nothing can be done in any operation.

It must be remembered that operation in these cases is not an innocent procedure, it can do many things which are harmful and but few that are helpful. It can sometimes relieve pressure when abnormal pressure exists and that is about all if we except such obvious things as removal of foreign bodies, and of blood clots, elevation of depressed fragments of bone and ligation of bleeding arteries.

From the standpoint of fractures, those of the skull are not of very great interest. The mere fact that a person has a linear fracture of the skull does not at all mean that an operation must be done. It seems to me that the indications for operations must be based upon a clear conception of the particular case in question, as to whether there is an intracranial lesion which is likely to be benefited by operation.

Bleeding from the ear has been mentioned as a particularly valuable symptom. I do not think that it is always necessary to call in a specialist with a tuning fork. I think the man who gives first aid can use an otoscope and see whether the bleeding comes from a ruptured drum or whether it is due to laceration of the soft tissues of the external meatus and due to traction on the external ear. In the absence of rupture of the drumhead, we all know how frequently hemorrhage takes place in the middle ear and pours into the pharynx, the first symptom of which may be vomiting, particularly in children. One skilled in the use of the otoscope can tell from the appearance of the drumhead whether there is blood behind it.

I do not feel, Mr. President, that I can here enter into any intimate discussion of traumatic injuries of the brain; it is too formidable a subject. I think the best I can do is to reiterate the statement I first made—that it is not a simple problem; that much harm can be done by injudicious operating; that it requires the best that is in a man, the best experience, the best knowledge, acumen and courage, to determine his course of action in these cases.

Dr. H. C. Naffziger: I am especially interested in Dr. Weeks' paper. The most noteworthy characteristic of the specimen shown is the hemorrhage in the frontal lobe. The symptomatology of frontal lobe injuries, as described by Phelps, comes at once to mind. This patient had the wild delirium associated with such injury. One particular point to be remembered in brain injuries is the great frequency of contusions and lacerations of the under surface of the frontal, and in the tips of the temporal lobes. The area uncovered by subtemporal decompression is the one we most often wish to explore, in addition to securing relief of pressure and drainage. I feel very much as Dr. Rixford does about the complexity of these brain injuries and believe we confuse ourselves by loose terminology. We talk of fractured skulls and their symptoms and include everything, mixing in symptoms of bone injury with symptoms of brain contusion, laceration and compression. Any one may occur alone. Usually the mere presence of a bone fissure is of no consequence in the absence of cerebral injury. For teaching purposes we have been accustomed to classify, into three types, cases needing surgical treatment: First, the group with depression fractures, including punctured wounds. Second, that group showing symptoms and signs of a localized brain involvement, most often a hemiparesis of varying depths. These may appear early, but most often after hours or days and associated with more or less marked symptoms

of intracranial tension. This is the group with intra and extra dural hemorrhages. Third, those which have simply general symptoms of acute cerebral compression. These are the hardest to interpret. I believe the interpretation of intracranial pressure early, after severe head trauma, to be one of the difficult problems in the diagnosis of brain surgery.

Dr. Stanley Stillman: I suppose the object in bringing up this subject before the Ear, Nose and Throat Section is to bring out points in these cases which are of interest to the ear, nose and throat specialists. There has been some discussion lately on the subject Dr. Welty referred to, in the matter of doing mastoid operations in all cases of fracture of the base, in which hemorrhage from the ear took place. I have an idea that some proposition of that kind was in the minds of those who suggested this paper instead of the subject of fractures of the skull in general, most of which do not concern the nose and throat men. So far as Dr. Welty's statement is concerned I would say that my own experience has mostly been with those cases in which the patient is in no condition to tell whether he has bone conduction or not. There are sufficient symptoms of brain injury or pressure to make the diagnosis and the patient is usually unconscious.

In suspected cases the absence of bone conduction on one side might be a symptom of value should the subsequent developments call for operation.

The mere fact that there is a fissure of the skull is not sufficient reason for doing a mastoid operation or any other operation.

I have seen a number of cases of fissure of the base of the skull without depression, accompanied by symptoms of profound laceration or disintegration of the brain in the vicinity of the fracture, or in a remote part of the brain, but there was nothing that would lead me to suspect that the condition would be improved by operation, nor in the autopsies was there anything to indicate that improvement would have resulted.

In the case of fractured skull with bleeding from the ear with or without escape of cerebrospinal fluid, I certainly would not subject the patient to any operation, except there were other indications. Compression from a blood clot, coming on as Dr. Weeks has stated, is a proper indication and there are others, but unless there were known to be previous mastoid disease or suppurative otitis media I would oppose opening the mastoid.

I think Dr. Weeks spoke of 70 per cent. recoveries after operation. Cases of fracture of the base of the skull with bleeding from the ear, etc., which recovered consciousness within a few hours and afterward showed no sign of pressure, would have recovered anyway I believe and would have been more apt to recover without operation.

My own position in these cases has been against operation unless some definite indication for operation was present.

Dr. H. B. Graham: I think the teaching heretofore has been about as Dr. Stillman has outlined: that is, if you have a reasonably clean ear, and a fracture through the middle ear or labyrinth, it is better surgery to leave that ear alone than to open the antrum, remove the mastoid cells and make drainage.

We take it for granted that the middle ear is an infected area. It has the same bacterial flora as the mouth, and some men claim that whether a suppurative process is going on in the middle ear or not makes no difference—that all of these cases should be treated as a fracture through an infected area and that this should be drained.

Some work along these lines has been done recently in Germany in the ear clinics, and a large number of cases have been operated, regardless of the condition of the patient; where there is a fracture on one side of the head involving the

ear. A recent article reported 125 cases in which group the percentage of recoveries was far greater than in years past. That this is good surgery I think has not been proved as yet. More work has to be done along the line of operating these doubtful cases before it will be proved whether it is necessary to look upon the middle ear as an infected area. My own experience has been very limited—only three cases of non-suppurating ears, all of them were left alone and all recovered. It is needless to say why I left them alone.

Dr. Stillman: The principal point seems to be whether these patients subsequently develop meningitis. I cannot recall, in a number of cases, any that died from meningitis after recovery of consciousness. It has not figured to any extent as the cause of death in my individual list, and I would like to ask if the experience of others has been that meningitis develops as often as we have been taught to fear that it will—so often as to justify a mastoid operation in all cases as a prophylactic measure.

Dr. K. Pischel: I need hardly point out that in these cases an ophthalmoscopic examination should be made. A slight swelling of the disk, if not a choked disk, will let us know whether we have to deal with pressure.

Dr. Weeks, closing discussion: I regret that Dr. Rixford did not come soon enough to find out that I do not think these cases are simple!

As to bleeding from the ear, it may surprise you to know that we have a great number of so-called fractures of the skull with bleeding from the ear, who go home well. I have even seen cases with cerebrospinal fluid coming from the ear who without interference recovered.

The reason I wrote this paper so filled with generalities was that it would take a week of writing to cover the ground explicitly. What I wanted to do was to call attention to the fact that when we call you down to see your patients at the Emergency Hospital, whenever we can find out to whom the patient belongs, the first thing nine of ten doctors do is to begin to paw the head over to find out whether the skull is cracked; and I want to emphasize the fact that it doesn't make a bit of difference whether it is cracked or not. The doctors should keep their minds on fractured brain tissue, not on skulls. The cases that have received trauma to the brain run something over 200 a year in the Emergency Hospitals, and that does not include simple concussion. I believe, as Phelps has brought out, that concussion is a definite injury to brain tissue.

The thing I wanted to bring before this section was that the nose, ear, and eye men are of absolutely no use on earth to the general surgeon when he has an acute trauma of the brain to deal with. We are interested in knowing in time as to the injury to the bulb, and it happens repeatedly that the ear and naso-pharynx will pour blood and they will vomit plenty of old blood which has come from a fracture somewhere in the naso-pharynx or middle ear, and a number of these cases recover. The point is whether the bulb is involved, and if we have evidence that it is being pressed upon, something must be done. For instance, you may have a patient with the usual slow pulse and high blood-pressure of compression, with at the same time a breathing that is wicked, Cheyne-Stokes very marked. It seems reasonable to think that the breathing center itself could have been involved, that the others are beginning to be involved, and that our only hope is to try in some way to relieve the pressure on these tissues. I have operated on some forty cases where on opening the dura the brain poured through the opening. At autopsy these brains were found filled with hemorrhages. It seems to me that the one hope is to relieve that pressure.

The changes in the eye grounds, choked disk and hemorrhages, are certainly late symptoms of

pressure. Things have gone a great distance then. To try whether they can hear the tuning fork is ridiculous! If a man has gone along far enough to have ear infection, that is in the hands of the ear specialist and he ought to relieve it.

Dr. Graham: Do many of these cases that have concussion of the brain die of meningitis?

Dr. Weeks: Death from meningitis is very rare in these cases.

## ANOCI-ASSOCIATION: A PLEA FOR THE SURGICAL PATIENT.\*

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It is not my purpose on this occasion to discuss the theories upon which anoci-association is based, attractive and interesting though they are, nor to trespass upon your time with an unnecessary description of technic; but with the patient and the patient's welfare for our themes to show you, if I may, the practical advantages which the method has to offer.

The biggest words in the vocabulary of the conscientious surgeon, without a doubt, are the safety and comfort of his patients. Dexterity is a gift which all may not possess. Speed in operating may be acquired by cultivation and is desirable enough provided it does not involve a greater loss than gain. But the thing of supreme importance is that no patient shall be exposed to any danger possible to be avoided.

It will not be disputed that shock constitutes the greatest danger of modern surgery. Sepsis and hemorrhage to which so large a per cent. of surgical mortality was formerly due, no longer give us concern. The great question remaining to-day, with the surgeon in advising operation as with the patient in considering it, is with what degree of danger will the proposed work be attended? The average patient does not know this danger as shock; the surgeon, even, may call it or think of it by some other name; but properly understood, shock is what both dread.

I have been surprised more than once recently to hear surgeons of wide experience declare that they do not fear shock,—that they never see it in their work. Such statements, manifestly, can only be based upon an inadequate conception of what the term really means. I do not hesitate to express the positive opinion that some degree of shock attends the performance of every major surgical operation, and this opinion is supported both by weight of authority and by the accepted teachings as to the true nature of the condition. It is true that extreme shock, as marked by collapse on the table and the necessity of resorting to heroic measures to sustain or restore life, is comparatively rarely seen. But how often, I would ask, does the careful surgeon perform major operations of an hour's duration that he does not feel it necessary to institute such post-operative treatment as the application of heat externally, hypodermic medication, the Murphy drip, etc.? Why does he adopt these measures, practically as a routine, in these cases? If the patient's condition is as it should

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